Petrous Apex Lesions

ANATOMY

- Situated lateral and adjacent to clivus.
- Petrous apex bisected by Internal auditory canal in coronal plane Anteriorly into peritubal area and posteriorly into perilabyrinthine area.
- Anterior to the internal auditory meatus that is wedged between the posterior border of the greater wing of the sphenoid and the basilar part of the occipital bones.
- Its borders and boundaries are marked by major blood vessels and structures, the superior and inferior petrosal sinuses above and below, and the horizontal segment of the internal carotid artery (ICA) and Eustachian tube laterally.
- The apex forms the posterolateral boundary of the foramen Lacerum.
- Apex is preformed in cartilage.
- The trigeminal ganglion lies in a depression on its posteromedial aspect and the abducens nerve crosses its superior surface beneath the petrosphenoidal ligament.
- Degree of pneumatization is variable (Peritubal area frequently pneumatized)

LESIONS AND THEIR PRESENTATION

- Epidermoid cysts appear as areas of fairly low signal intensity in the T1 images and of high intensity in the T2 images.
- **Cholesterol granuloma** cysts are instead **bright in both sequences** because of short T1 and long T2 relaxation times.
- Cholesterol granuloma, cholesteatoma(epidermoid cyst), and mucocele account for 99% of primary cystic lesions of the petrous apex, with cholesterol granuloma being the most common.

PATHOLOGY OF CHOLESTEROL GRANULOMA

- **Cholesterol granuloma** results from obstruction of and hemorrhage into a previously aerated space and may also arise from rapid fluctuation of air pressure within the narrow air channels leading to the petrous apex.
- An expansile cyst fills the obstructed cells, lined by fibrous tissue and containing chocolate brown or black fluid filled with chronic granulation tissue and cholesterol crystals.
- As the cyst expands, the involved air cells dilate and the surrounding bone erodes.
- **Cholesteatoma (epidermoid cyst)** consists of an epithelial wall, fibrous subepithelium, and keratin debris.
- *The presence of epithelium distinguishes cholesteatoma from cholesterol granuloma.*
- Epidermoid rests are thought to arise near the foramen Lacerum and can be distinguished from dermoid cysts that have skin adnexae (eg, sweat glands).
As the cholesteatoma expands, bone erosion may result from osteolytic enzymes at the junction of the epithelium and fibrous subepithelium.

A mucocele results from obstruction of drainage from a highly pneumatized petrous apex and also can produce an expansile cystic lesion.

**CLINICAL PRESENTATION**

**Symptoms**

- Petrous apex findings (“lesions”) can be asymptomatic and discovered coincidentally on MRI.
- Coincidently found lesions which were asymptomatic were usually benign
- Most published reports of symptomatic petrous apex lesions include primary and secondary neoplasms.
- Most published reports of symptomatic petrous apex lesions include primary and secondary neoplasms and list **hearing loss** as the most common presenting symptom.
- Non-neoplastic, primary cystic lesions of the apex, however, more often present with headache, head pain, or aural pressure.
- Headache is usually ipsilateral and retro-orbital or temporoparietal but also can be referred to the occiput or vertex.
- Hearing loss occurs when the eustachian tube is compressed (conductive loss) or the internal auditory canal or inner ear is invaded(sensorineural hearing loss) and can be accompanied by tinnitus.
- Rarely inner ear involvement may lead to vertigo.
- Gradinego’s Syndrome
- Trigeminal nerve compression can produce hypesthesia or paresthesia, especially along the distribution of the mandibular branch (V3).
- **Facial palsy and spasm** from seventh cranial nerve compression and **diplopia** from sixth cranial nerve compression are uncommon.
- **Ophthalmoplegia** from anterior extension into the cavernous sinus is rare. **Syncope** also is rare and suggests carotid artery compression. **Otorrhea** can result from secondary infection and drainage of the cystic lesion.

**SIGNS**

- Otoscopy is usually normal but can reveal drum retraction, middle ear effusion, or drainage
- Hypesthesia of cranial nerve V and palsy of cranial nerves VI or VII are uncommon.

**AUDIOMETRIC AND VESTIBULAR EVALUATION**

- The audiogram can be normal or reveal conductive, sensorineural, or mixed hearing loss. Vestibular testing can detect canal paresis from inner ear involvement.

**RADIOLOGIC EVALUATION**

- **Cholesterol granuloma** cysts are instead **bright in both sequences** because of short T1 and long T2 relaxation times
- Cholesteatoma and Mucocele is Hypodense on T1 but bright on T2
- A CT scan can show whether the cyst is expansile.
An expansile cyst usually requires surgery; a nonexpansile cyst usually does not.

**CLINICAL EVALUATION**

- Ipsilateral retro-orbital pain is relatively specific for petrous apex disease, but some patients present with ear pain or pressure and temporoparietal headache.
- The facial nerve refers pain to the external ear canal and postauricular region.
- Trigeminal referred otalgia arises from lesions involving the oral cavity and floor of the mouth, teeth, mandible, temporomandibular joint (TMJ), palate, and preauricular skin. Glossopharyngeal referred otalgia arises from the tonsil, base of the tongue, soft palate, nasopharynx, eustachian tube, and pharynx. Vagal referred otalgia arises from the hypopharynx, larynx, and trachea.

**SURGICAL APPROACH**

- For hearing preservation, the middle cranial fossa and infracochlear (hypotympanic) approaches are used for management of benign, non-neoplastic, cystic lesions of the petrous apex.
- For very large lesions, when additional exposure and control of the carotid artery are required, the transcochlear approach can be used with extension into the infratemporal fossa if necessary.
- Because MRI provides very sensitive, early detection of smaller apical lesions, the transcochlear-infratemporal fossa approach is rarely needed.

**THE MIDDLE CRANIAL FOSSA (TRANSPETROSAL) APPROACH (EAGLETON’S)**

- To the petrous apex is used to excise rather than simply drain the cyst and is the procedure of choice when the cyst location and lack of hypotympanic pneumatization make the infracochlear approach difficult.
- The middle cranial fossa approach provides good access to the cyst for total excision in most cases except those cysts that extend inferiorly or those that encircle the carotid artery.
- STEPS:
  - GA ➔ Subarachnoid drain with 80cc CSF drainage ➔ Facial and auditory monitoring electrodes in place ➔ INCISION. A subtemporal, 6-cm vertical incision extends superiorly from the zygomatic process, 1 cm anterior to the external auditory canal ➔ A 3 X 2.5 cm bone flap is removed, and the temporal lobe is elevated extradurally to reveal the foramen spinosum anteriorly, arcuate eminence posteriorly, and superior petrosal sinus medially ➔ Temporal lobe traction is gently maintained with a Greenberg retractor ➔ GSPN identified and followed posteriorly to geniculate ganglion confirmed by facial nerve stimulator ➔ avoid basal turns of cochlea just anterior and medial to the ganglion ➔ Both Glasscock and kawase triangles provide access to the apex and preserve the GSPN to avoid postoperative dry eye; however, in large lesions, the GSPN can be sacrificed to provide greater exposure ➔ Just deep to the GSPN is the petrous carotid artery, which can be distinguished from cyst wall by its location, pulsation, and more reddish color. Just lateral to the artery is the eustachian tube ➔ Removal of bone proceeds anterior to the basal turn of the cochlea, down to the cyst wall with identification and preservation of the GSPN, carotid artery, and eustachian tube ➔ Cyst dissected and fluid sucked out ➔ wall of cyst probed to
find out extent ➔ now for complete excision, sectioning of GSPN or eustachian tube may be required (Traversing the center of larger cysts is the carotid artery, which must be carefully preserved.) ➔ Cyst wall removed by blunt dissection ➔ retractor removed ➔ temporal lobe allowed to reexpand ➔ bone flap refixed using miniplates and screws ➔ Temporalis muscle and fascia layer closed ➔ local drain not needed ➔ sterile compression dressing applied over ear and side of head.

- For mucocele and cholesterol cyst, a pressure equalizer can be placed in the drum (not required for epidermoid cyst.)
- The subarachnoid drain is removed in the operating room.

- Between the foramen spinosum and arcuate eminence, the GSPN divides the petrous apex into the lateral Glasscock’s triangle and the medial Kawase’s triangle (GLASSCOCK's triangle ➔ Medially GSPN, base mandibular division of trigeminal and laterally by line from the foramen spinosum to arcuate eminence. Kawase's triangle : Laterally GSPN, Medially petrous ridge(superior petrosal sinus) and base arcuate eminence).
- The wall of the most common cystic lesion, cholesterol granuloma, is usually bluish and nonpulsatile but can be fibrotic and surprisingly thick.

THE INFRACOCHLEAR-HYPOTYMPANIC APPROACH (FARRIOR’S)

- Conservative, safer and simpler approach to provide only drainage, decompression and/or ventilation and not excision of cysts.
- CT scan should be obtained to reveal adequate pneumatization between the cyst wall and the hypotympanum.
- STEPS ➔
  - GA ➔ No need of facial and auditory monitoring, nor subarachnoid drain ➔ INCISION superior placed radical incision 8 mm lateral to the annulus ➔ Post auricular incision with temporalis fascia graft (2x2.5cm) harvested ➔ Mastoid periosteum incised in T fashion and elevated till u reach the radical incision ➔ Auricle retracted Anteriorly ➔ enter middle ear after elevating canal wall and annulus ➔ Drill used to remove additional inferior tympanic ring to enlarge hypotympanic exposure ➔ drilling proceeds inferior and medial to cochlea between the anterior carotid artery and the posterior jugular bulb ➔ The air cells connecting the middle ear with the apex can be gently curetted or drilled to enhance postoperative drainage ➔ A short, Silastic® catheter is placed into the connecting air cells ➔ Temporalis fascia or areolar tissue is used to line and reinforce the enlarged inferior annular ring, and the tympanic membrane is replaced in its normal position ➔ A PE tube can be placed and the canal filled with antibiotic ointment ➔ Postauricular tissues are closed in two layers.

TRANSCOCHLEAR APPROACH

- Hearing destroying surgeries
- Greater exposure, for large lesions and where carotid artery needs to be controlled.
- The translabyrinthine transcochlear approach is a variation that combines transmastoid and cervical approaches.
- In both the transcochlear and translabyrinthine approaches
- Facial monitoring required
- Steps not necessary (from book)
All Approaches include:

- EAGLETON'S MIDDLE CRANIAL FOSSA APPROACH
- FRENCKNER’S SUBARCUATE APPROACH (through arch of superior semicircular canal)
- THORNWALDT’S RETRO-LABYRINTHINE APPROACH
- DEARMAN & FARRIOR’S INFRA-LABYRINTHINE APPROACH
- FARRIOR’S HYPOTYMPANIC SUB-COCHLEAR APPROACH
- LEMPERT RAMADIER’S PERI-TUBAL APPROACH
- KOPETSKY ALMOOR’S PERI-TUBAL APPROACH